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(54) High-pressure gas discharge lamp.

(57) The high-pressure gas discharge lamp according to the invention has at least one electrode comprising an electrode rod (44) and a helical winding (46) near its tip (45) projecting into the lamp vessel, both mainly of tungsten. The winding (46) has a first layer of turns (47) directly around the rod (44) with locally a turn (51) of high pitch P. The winding (46) has around the first layer (47) another layer of turns (50) which is wound in opposite direction and has a turn (52) of high pitch gripping around the said turn of high pitch (51), whilst forming therewith contact areas (53) located diametrically opposite to each other, between which the said turn (52) engages the rod (44) with clamping fit. An additional turn (60) is disposed over the turn (52). The winding (46) is fixed very firmly on the rod (44).

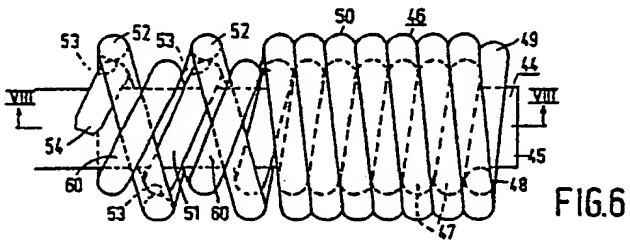

FIG.6

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High-pressure gas discharge lamp

The invention relates to a high-pressure gas discharge lamp comprising a translucent lamp vessel, which is sealed in a vacuum-tight manner, is filled with an ionizable gas and has electrodes projecting into the lamp vessel and being connected to current supply conductors which extend to the exterior through the wall of the lamp vessel,

-at least one of said electrodes comprising a rod of mainly tungsten, which has near its tip projecting inside the lamp vessel a helical winding of wire of mainly tungsten, a first layer of turns of which being arranged to surround the rod and another layer of turns being arranged to surround said first layer, said first layer of turns locally having a turn of high pitch P being at least equal to the wire diameter of said first layer of turns plus the wire diameter of said other layer of turns,

-said winding being fixed on the rod.

Such a lamp is known from US-PS 3,170,081.

The winding around the electrode rod only has for its object to obtain a satisfactory temperature variation over the electrode or to also hold electron-emitting material.

It is necessary to fix the winding on the rod, for example by deforming a turn in the hot state so that it is caused to clamp around the rod or by welding the winding locally to the rod.

In the lamp according to the aforementioned US-PS 3,170,081, the first layer of turns is a body, which is slipped with a certain amount of clearance around the electrode rod and is fixed on it by deforming the layer in the hot state, while the other layer of turns is a separate body slipped around the first layer. In order to fix the second layer of turns, the first layer of turns has a projecting wire portion at its end remote from the tip of the electrode rod, while the other layer of turns has at the corresponding end a wire portion bent towards the rod. This electrode construction renders it difficult to manufacture the electrodes and therefore the lamp.

The non-prepublished European Patent Application 86201239.0 (PHN11446) of the Applicant discloses a lamp of the kind described in the opening paragraph, in which the other layer of turns of the winding of the electrode grips at least twice around a turn of high pitch of the first layer, whilst forming an equal number of contact areas and engaging with clamping fit the electrode rod at least substantially diametrically opposite to those contact areas. The turn(s) of the other layer of turns gripping around a turn of high pitch of the first layer has (have), according to this Application, a pitch corresponding to the pitch of the remaining turns of the other layer of turns, i.e. equal to the wire diameter.

The invention has for its object to provide a high-pressure gas discharge lamp of the kind mentioned in the opening paragraph, of which at least one of the electrodes has an overwind of simple construction that can readily be manufactured and in which the winding is nevertheless firmly fixed on the electrode rod.

According to the invention, this object is achieved in a high-pressure gas discharge lamp of the kind mentioned in the opening paragraph in that the other layer of turns is wound in a direction opposite to that of the first layer and has at least one turn having a pitch corresponding to the pitch P and gripping around a turn having a pitch P of the first layer of turns, whilst forming therewith contact areas located substantially diametrically to each other, and engaging between each pair of contact areas the electrode rod with clamping fit.

In contrast with the electrodes according to the aforementioned US-PS 3,170,081, in which the electrodes are assembled from separately manufactured bodies, the at least one electrode of the lamp according to the invention can be obtained in that the winding is composed on the electrode rod itself acting as a winding mandrel. During the manufacture of the electrode, an assembling step is thus dispensed with, which is advantageous especially if the electrode, the rod and the winding are small and consequently vulnerable. Furthermore, a separate step for fixing the winding is dispensed with. Nevertheless the winding of the electrode is firmly fixed.

The fixing of the winding on the electrode rod can be explained as follows. When a wire is wound around a mandrel (a rod), the turns of said wire have a tendency to assume a larger diameter. In the case of a round mandrel, this larger turn diameter is obtained in that the wire can slide tangentially along the mandrel due to elastic relaxation.

This also applies to a second layer of turns, which is disposed on a first layer of turns, if said second layer is wound in the same direction as the first layer. Also in this case, the "mandrel", i.e. the rod onto which the first layer was wound, together with said first layer is round. If said second layer of turns, however, is wound in the opposite direction, the "mandrel" is not purely round because the turns of said second layer must each time jump over the turns of the first layer. The "out-of-roundness" of the mandrel is very small. The deviation from the round form has the size of only a fraction of the wire diameter, while the "mandrel" diameter is comparatively large, i.e. equal to the diameter of the rod onto which there is wound plus twice the

wire diameter. Due to said small "out-of-roundness", the wire can slide tangentially also in this case, as a result of which the turns assume a larger diameter and the layers become loosely arranged.

If a wire is wound around a rod with locally a high pitch P, the assembly of rod and wire is very unround in situ . The circumference of a cross-section of the rod and the wire is oval. Turns of another layer of turns, which are wrapped like a shell around the rod and the wire, substantially cannot slide tangentially and thus cannot be relieved. This is the case if this other layer of turns is wound in the same direction as the first layer, but also if it is wound in opposite direction. The winding of the rod is fixed thereon when at least a part of the other layer of turns cannot be relieved due to the fact that said part is situated between two areas at which the other layer of turns is held in that a tangential displacement is not possible. Also if the first layer of turns is integral with the other layer of turns and the other layer of turns grips like a shell, whilst forming at least an equal number of contact areas therewith, at least once around a turn of high pitch of the first layer of turns and around the mandrel, at least a part of the other layer of turns is situated between two areas at which the other layer of turns is held. The first area is that at which the first layer of turns passes into the other layer of turns. The second area is that at which the other layer of turns grips around a turn of high pitch P in the first layer.

The fixing of the winding on the electrode rod of the lamp according to the aforementioned non-prepublished European Patent Application 86201239.0 is based on the facts set out in the preceding paragraph.

In the at least one electrode of the lamp according to the invention, a turn of high pitch of the other layer of turns forms contact areas arranged diametrically to each other with a turn of high pitch P in the first layer of turns. This turn engages the electrode rod with clamping fit between each pair of these contact areas. The "mandrel" onto which this turn of high pitch is wound is therefore very unround. Tangential displacement of this turn so as to be relieved is therefore counteracted in a very reliable manner.

In a favourable embodiment, the first layer of turns and the other layer of turns are integral with each other and near the tip of the electrode rod a turn of the first layer of turns passes into a turn of the other layer of turns.

In a preferred embodiment thereof, the said turn of high pitch P in the first layer of turns is present at the end of the winding remote from the tip of the electrode rod.

The use of such a winding, whose layers are integral with each other further simplifies the manufacture of the electrode. In the preferred embodiment, the additional advantage is obtained that the turns are in intimate contact both with each other and with the electrode rod. As a result, a satisfactory heat transfer from the rod to its winding is obtained.

In a variation, the other layer of turns is integral with an additional turn, which is disposed on the turn of high pitch in the other layer of turns, this additional turn extending mainly parallel to the turn of high pitch P of the first layer of turns and being in contact with the electrode rod. It has been found that in this variation the winding is very firmly fixed. This becomes manifest, for exmaple, when the winding is made of a comparatively thick wire.

In order to explain the term "pitch", it should be noted that, if turns are made having a pitch equal to the wire diameter, adjacent turns engage each other laterally.

The electrode and hence the high-pressure gas discharge lamp can be manufactured even more readily if the winding of the electrode has a wire end with a rupture surface. Such a rupture surface is obtained in that, after the process of helically winding has been accomplished, the remaining wire portion not wound helically is severed from the winding by tearing it off. The wire then breaks at the area at which it loses its contact with the electrode.

Rupture surfaces have a characteristic appearance, as a result of which they are easily recognized as such by those skilled in the art. They have a rough surface, which is dull due to the roughness. They further are devoid of tracks, such as grooves or a burr, which are left in or at a separation surface by tools, for example cutting, pinching, shearing or grinding tools.

When the winding is made around the electrode rod, the beginning of the wire is held in a clamp. When the winding is finished, this beginning can be severed in a corresponding manner by tearing it off the winding.

The lamp according to the invention may be a high-pressure sodium lamp provided with a ceramic vessel of, for example, (polycrystalline) aluminium oxide or (monocrystalline) sapphire, or a high pressure mercury discharge lamp, which may contain metal halides and has a ceramic or quartz glass lamp vessel.

Embodiments of the lamp according to the invention are shown in the drawing. In the drawing:

Figure 1 shows a high-pressure sodium discharge lamp in side elevation broken away with diagrammatically indicated electrodes;

Figure 2 shows a high-pressure mercury discharge lamp in longitudinal sectional view with diagrammatically indicated electrodes;

Figure 3 shows an electrode in side elevation;

Figure 4 shows the electrode of Figure 3 in longitudinal sectional view;

Figure 5 shows the electrode of Figure 3 in sectional view taken on V-V;

Figure 6 shows another embodiment of the electrode in side elevation;

Figure 7 shows the electrode of Figure 6 in longitudinal sectional view;

Figure 8 shows the electrode of Figure 6 in sectional view taken on VIII-VIII.

The high-pressure sodium discharge lamp shown in Figure 1 has a translucent lamp vessel 1 of mainly aluminium oxide, which is sealed in a vacuum-tight manner and has an ionizable filling of sodium, mercury and xenon. Electrodes 2 project into the lamp vessel 1, which are connected to current supply conductors 3, which extend to the exterior through the wall of the lamp vessel. The electrodes 2 each have an electrode rod 4 of mainly tungsten, which near its tip 5 projecting inside the lamp vessel 1 has a helical winding 6 of wire of mainly tungsten. A first layer of turns having locally a turn of high pitch P at least equal to the wire diameter of the first layer of turns plus the wire diameter of another layer of turns of the helical winding 6 is arranged to surround the electrode rod 4, while another layer of turns is arranged to surround the first layer of turns. The winding 6 is fixed on the electrode rod 4. The electrodes 2 are described more fully with reference to Figures 3 to 5, while alternative electrodes are described with reference to Figures 6 to 8. The lamp vessel 1 is arranged in an outer envelope 7, which is sealed in a vacuum-tight manner and has a lamp cap 8.

The high-pressure mercury discharge lamp of Figure 2 has a quartz glass lamp vessel 11, which is sealed in a vacuum-tight manner and has an ionizable filling of argon, mercury, sodiumiodide, scandiumiodide and thalliumiodide. Electrodes 12 connected to current supply conductors 13a, 13b projecting from the lamp vessel 11 to the exterior project into the lamp vessel 11. They have an electrode rod 14 of mainly tungsten, which has at its tip 15 projecting inside the lamp vessel 11 a helical winding 16 of wire of mainly tungsten. A first layer of turns locally having a turn of high pitch P at least equal to the wire diameter of the first layer of turns plus the wire diameter of another layer of turns of the helical winding 16 is arranged to surround the electrode rod 14, while another layer of turns is arranged to surround the first layer of turns. The winding 16 is fixed on the electrode rod 14. The electrodes 12 are described with reference to Figures 3 to 5, while alternative electrodes are described with reference to Figures 6 to 8.

In Figures 3, 4 and 5, the electrode rod 24 of mainly tungsten has at its tip 25 projecting inside the lamp vessel a helical winding 26 of wire of mainly tungsten. The electrode rod 24 is directly surrounded by a first layer of turns 27, of which the last turn 28 passes near the tip 25 of the electrode rod 24 into the first turn 29 of another layer of turns 30, which is arranged to surround the first layer of turns 27. As a result, the first layer of turns 27 is integral with the other layer of turns 30.

The first layer of turns 27 locally has a turn 31 of high pitch P, which pitch P is at least equal to the wire diameter of the first layer of turns 27 plus the wire diameter of the other layer of turns 30. In the embodiment shown, the pitch P is therefore at least twice the wire diameter, as the first layer and the other layer are made of the same wire.

The winding 26 is fixed on the electrode 24 in that the other layer of turns 30 is wound in a direction opposite to that of the first layer 27 and has at least one turn 32 having a pitch corresponding to the pitch P, gripping round a turn 31 of pitch P of the first layer of turns 27, whilst forming therewith contact areas 33 located substantially diametrically to each other, and engaging the electrode rod 25 with clamping fit between each pair of contact areas 33. The turn 31 of high pitch P in the first layer of turns 27 is present near that end of the winding 26 which is remote from the tip 25 of the electrode rod.

In Figure 4, the contact areas 33 are clearly visible. Per whole turn 32 two such contact areas 33 are present due to the fact that the pitch of the turn 32 in the Figure is identical to the pitch P of the turn 31. If the pitch of the turn 32 should deviate from P, the number of contact areas per whole turn 32 would be a fraction larger or smaller.

In Figure 5, which is a sectional view which is drawn through the axis of the rod 24, rotated through 90° with respect to Figure 4, it is visible that the turn 32 engages with clamping fit the electrode rod 25 between each pair of contact areas 33 (cf. also Figures 3 and 4). The beginning 34 (Figure 3) of the first layer of turns 27 and the end 35 (Figure 4) of the other layer of turns 30 were obtained by tearing off excess wire. The turn 32 is very unround due on the one hand to its two contact areas 33 far remote from the axis of the rod 24 and on the other hand to the engagement with the rod 25 between these areas. The turn 32 can thus not be relieved and exerts a great frictional force on the rod 24, which counteracts displacement of the winding 26. Although the winding 26 is made of one piece of wire, the turns of the other layer 30 are for the sake of clarity differently hatched in Figures 4 and 5.

In Figures 6, 7 and 8, corresponding parts are designated by a reference numeral which is 20 higher than in the preceding Figures. The other

layer of turns 50 is integral with an additional turn 60 (nevertheless hatched differently for the sake of clarity), which is disposed over the turn 52 of high pitch in the other layer of turns 50 (Figure 8) and extends mainly parallel to the turn 51 of high pitch P of the first layer of turns 47 and is in contact with the electrode rod 44 (Figures 6, 7). The turn 60 is unround to the same extent as the turn 52 and thus provides an additional fixing of the winding 46. It is remarkable that the winding 46 in the drawing has the same transverse dimension near the tip 45 as at its other end in spite of the triple character of the winding 46 at the latter end.

A winding of tungsten wire having a diameter of 70 µm was disposed on a tungsten rod having a diameter of 200 µm. The winding consisted of two layers which passed into each other at one end of the winding. The winding had a length of approximately 1 mm. On the first layer of turns a welding connection with the rod was formed. It was found that the winding could be pushed off the rod by a force of 3 N.

With a rod and a wire of the same thicknesses, electrodes according to Figures 6 - 8 were manufactured. The winding had a length of approximately 1 mm. A force of 12 N was found to be required to push the winding off the rod. The largest diameter of the wound rod was approximately 480 µm, from which an intimate contact of the turns with each other and of these turns and the rod becomes apparent. The largest diameter of the wound rod described above with welded fixing was considerably larger. The turns therefore were arranged for the major part loosely with respect to each other and to the rod.

Claims

1. A high-pressure gas discharge lamp comprising a translucent lamp vessel, which is sealed in a vacuum-tight manner, is filled with an ionizable gas and has electrodes projecting into the lamp vessel and being connected to current supply conductors extending to the exterior through the wall of the lamp vessel,
-at least one of said electrodes comprising a rod of mainly tungsten, which has near its tip projecting inside the lamp vessel a helical winding of wire of mainly tungsten, a first layer of turns of which being arranged to surround the rod and another layer of turns being arranged to surround said first layer, said first layer of turns locally having a turn of high pitch P being at least equal to the diameter of said first layer of turns plus the wire diameter of said other layer of turns,
-said winding being fixed on the rod,
characterized in that the other layer of turns is wound in a direction opposite to that of the first layer and has at least one turn having a pitch corresponding to the pitch P and gripping around a turn of the pitch P of the first layer of turns, whilst forming therewith contact areas located substantially diametrically with respect to each other, and engaging between each pair of contact areas with clamping fit the rod.

2. A high-pressure gas discharge lamp as claimed in Claim 1, characterized in that the first and the other layer of turns are integral with each other and a turn of the first layer of turns passes near the tip of the electrode rod into a turn of th other layer of turns.

3. A high-pressure gas discharge lamp as claimed in Claim 2, characterized in that the said turn of high pitch P in the first layer of turns is present at the end of the winding remote from the tip of the electrode rod.

4. A high-pressure gas discharge lamp as claimed in Claim 1 or 3, characterized in that the other layer of turns is integral with an additional turn which is disposed over the turn of high pitch in the other layer of turns, which turn extends mainly parallel to the turn of high pitch P of the first layer of turns and is in contact with the electrode rod.

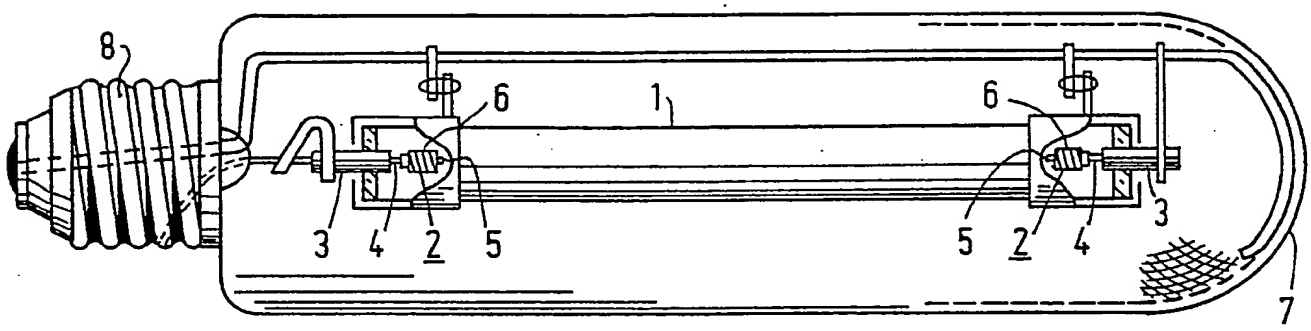

FIG.1

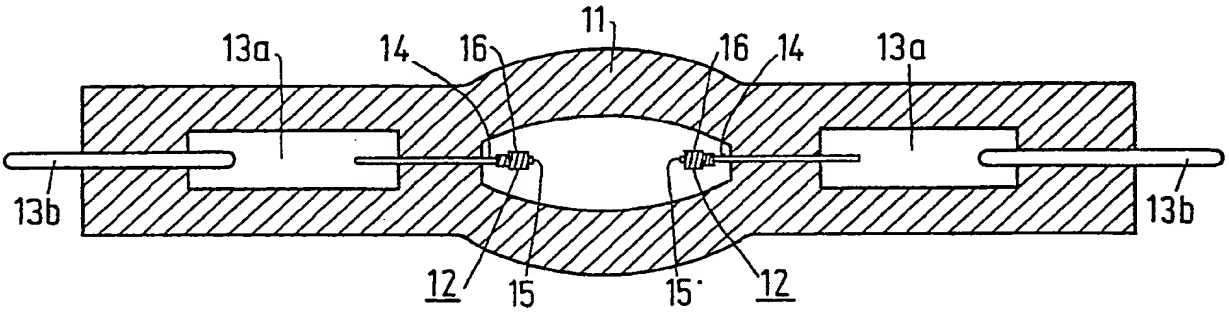

FIG.2

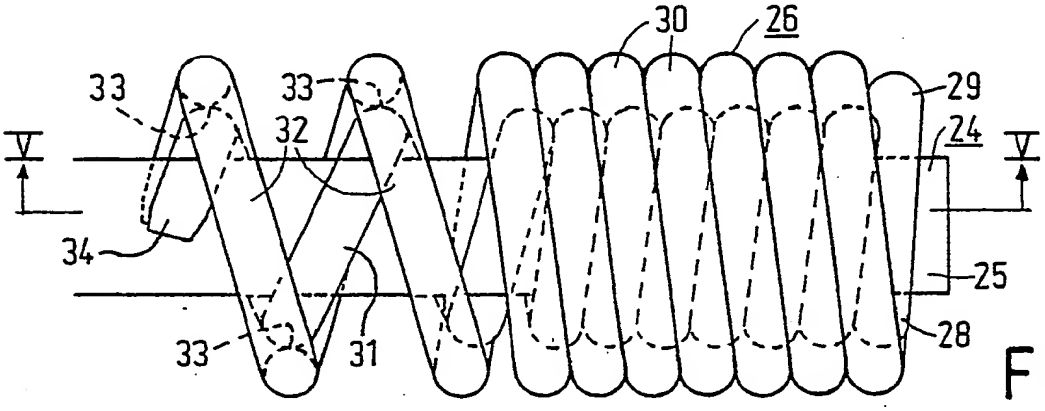

FIG.3

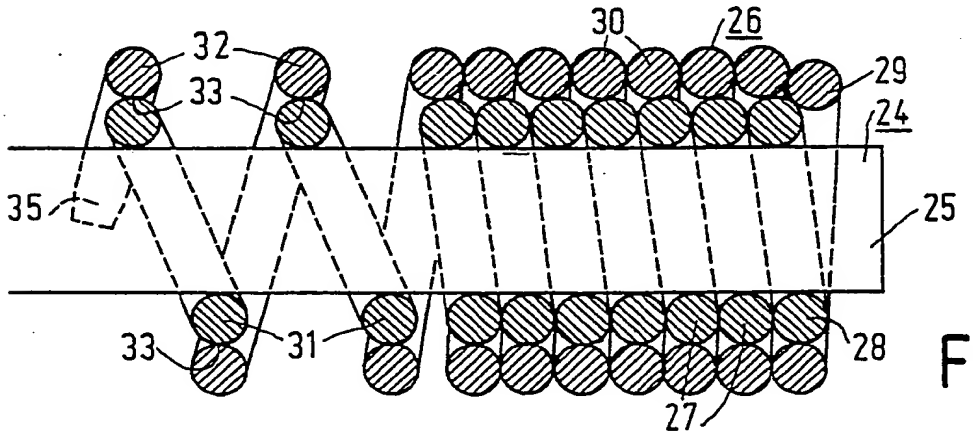

FIG.4

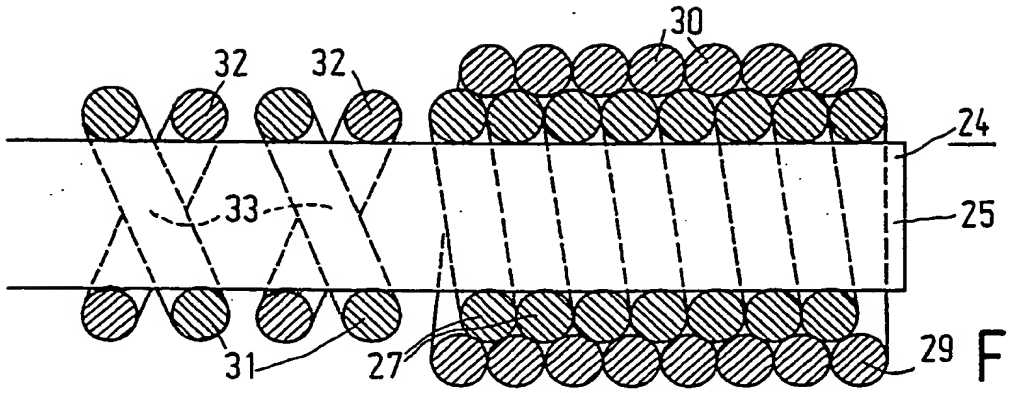

FIG.5

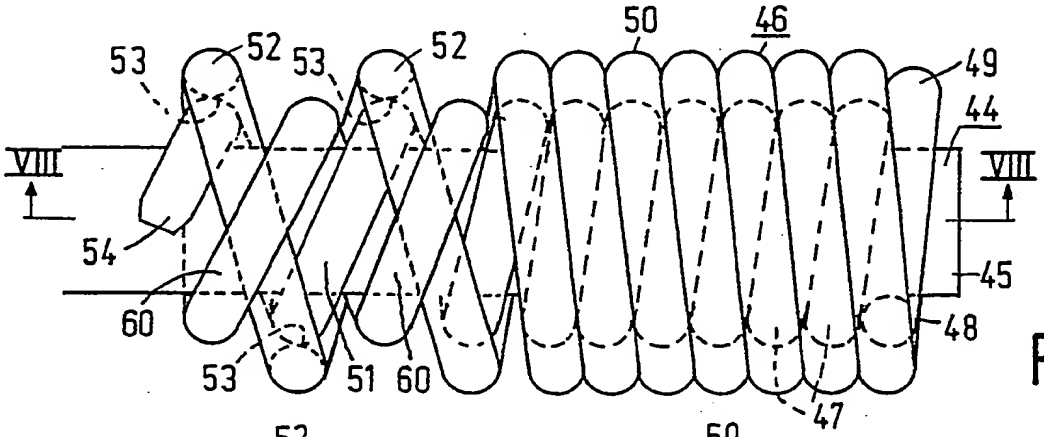

FIG.6

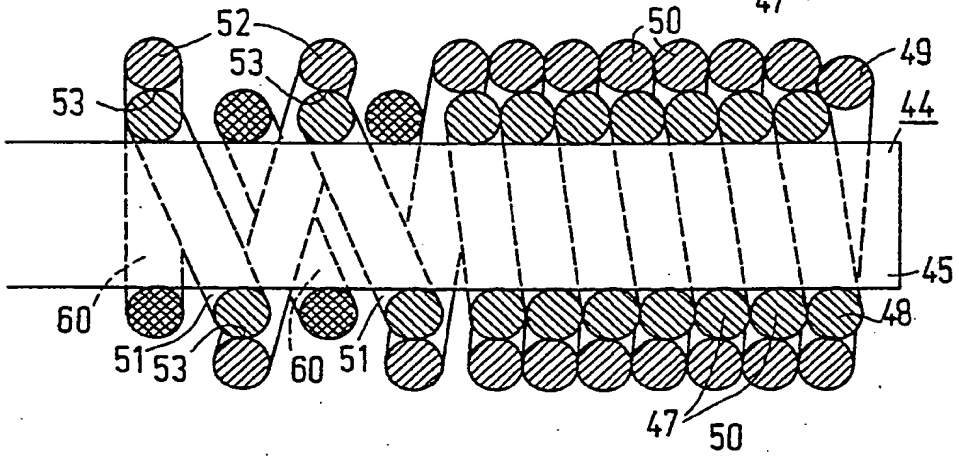

FIG.7

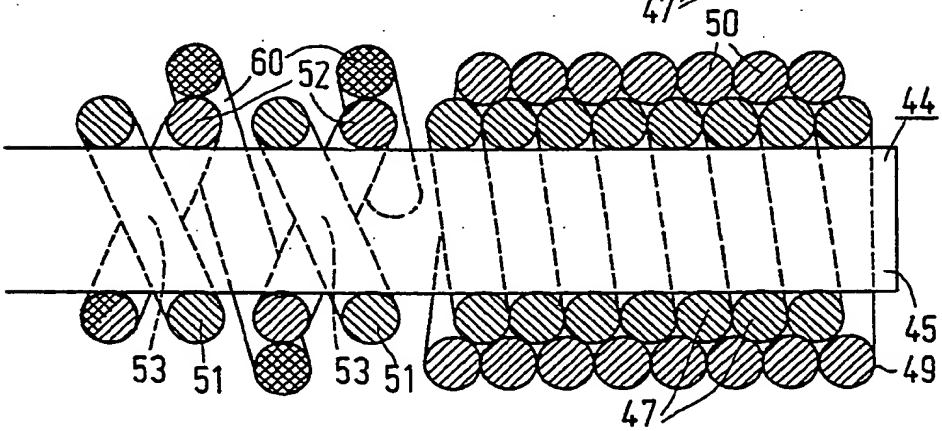

FIG.8

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 87 20 2458

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
D,A	US-A-3 170 081 (F. ROKOSZ) * Column 2, line 60 - column 5, line 20; figures 1-12 *	1	H 01 J 61/073
A	EP-A-0 193 714 (GENERAL ELECTRIC CO.) * Column 3, lines 8-37; figure 2 *	1	
A	DE-A-3 036 666 (PATENT TREUHAND GmbH) * Whole document *	1,2	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

H 01 J 61/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	04-03-1988	SARNEEL A.P.T.

CATEGORY OF CITED DOCUMENTS

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